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On the decadal variability in the Subpolar North Atlantic and its recent abrupt cooling trend

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The subpolar North Atlantic (SPG) is a key region known to have important climate impacts of the nearby continents of North America and Europe. Studies have shown evidence that warm anomalies in the region in the mid-1990s may result in increased hurricane numbers. The extremely cold anomaly in SPG in 2015 is likely the cause of the European summer heatwave. Observation and model studies suggest that the SPG exists large decadal variability, while there is no long-term warming in the region, in contrast to the global warming in response to the anthropogenic forcing. In particular, it is observed that since the beginning of the 20th century, the SPG experiences an abrupt cooling, after the rinsing of temperature for more than a decade in 1990s. Model studies suggested that abrupt SPG cooling may result from either disruption of the Atlantic Meridional Circulation (AMOC) or a collapse of SPG convection, both are possible responses to the global warming trend.

In this study, we investigate the natural and forced variability on decadal timescales in the North Atlantic subpolar gyre region (SPG). The SPG temperature changes in the ocean and atmosphere reanalysis datasets are assessed and compared with ensembles of CMIP6 control experiments and CMIP5/CMIP6 historical and future scenarios. Large decadal variability is found in the SPG temperature. Warming and cooling trends of decadal timescales comparable with the observed amplitudes occur frequently and alternatively, in both unforced and climate change experiments. The ocean and atmosphere conditions associated with the warming and cooling trends are analyzed to understand the mechanism.